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Interim Report
GUNNISON-ARKANSAS PROJECT
Colorado

SEPTEMBER 1949

APPENDIX B
Potential Development

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PROPOSED REPORT
OF REGIONAL DIRECTOR
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Appendix, Volume II of XVI
Project Planning Report No. 8a.49-1

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LIST OF SUPPORTING APPENDIX REPORTS

This report, prepared by the Bureau of Reclamation, is supported by the following detailed appendix reports:

Appendix Designation		Volume No.
A	General Discussions	I
B	Potential Development	II
C	Designs and Estimates	III
D	Water Supply	IV
E	Project Lands	V
F	Agricultural Economy	VI
G	Power	VII
H	Flood Control	VIII
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J	Drainage	X
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P	Financial Analysis	XV
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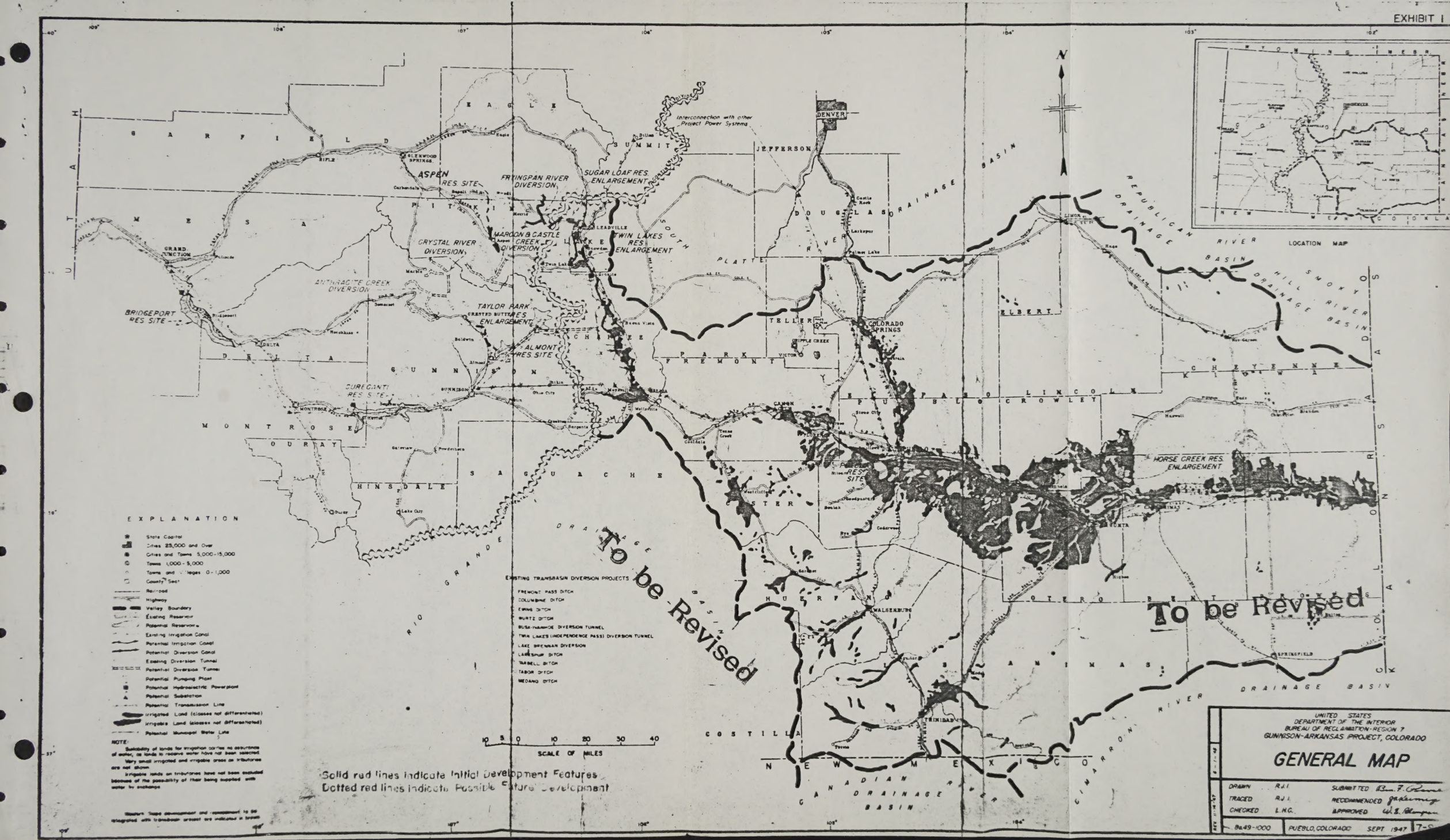
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PROPOSED REPORT
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EXHIBIT I


ASPEN RES. SITE
FRYINGPAN RIVER DIVERSION
SUGAR LOAF RES. ENLARGEMENT
Interconnection with other Project Power Systems
MAROON & CASTLE CREEK DIVERSION
CRYSTAL RIVER DIVERSION
TWIN LAKES RES. ENLARGEMENT
ANTHRACITE CREEK DIVERSION
BRIDGEPORT RES. SITE
TAYLOR PARK CRESTED BUTTE RES. ENLARGEMENT
ALMONT RES. SITE
CURECANTI RES. SITE
HORSE CREEK RES. ENLARGEMENT
To be Revised
To be Revised
EXISTING TRANSBASIN DIVERSION PROJECTS
FREMONT PASS DITCH
COLUMBINE DITCH
EWING DITCH
BURTZ DITCH
BUSH-HAMMOND DIVERSION TUNNEL
TWIN LAKES (INDEPENDENCE PASS) DIVERSION TUNNEL
LAKE BRENNAN DIVERSION
LAKESHORE DITCH
TARBELL DITCH
TABOR DITCH
MEDANO DITCH
EXPLANATION
State Capital
Cities 25,000 and Over
Cities and Towns 5,000-15,000
Towns 1,000-5,000
Towns and Villages 0-1,000
County Seat
Railroad
Highway
Valley Boundary
Existing Reservoir
Potential Reservoirs
Existing Irrigation Canal
Potential Irrigation Canal
Potential Diversion Canal
Existing Diversion Tunnel
Potential Diversion Tunnel
Potential Pumping Plant
Potential Hydroelectric Powerplant
Potential Substation
Potential Transmission Line
Irrigated Land (classes not differentiated)
Irrigable Land (classes not differentiated)
Potential Municipal Water Line
NOTE:
Suitability of lands for irrigation carries no assurance of water, as lands to receive water have not been selected.
Very small irrigated and irrigable areas on tributaries are not shown.
Irrigable lands on tributaries have not been excluded because of the possibility of their being supplied with water by exchange.
Western Slope development and replacement to be integrated with transbasin project are indicated in brown.
SCALE OF MILES
10 5 0 10 20 30 40
Solid red lines indicate Initial Development Features
Dotted red lines indicate Possible Future Development
LOCATION MAP
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION-REGION 7
GUNNISON-ARKANSAS PROJECT, COLORADO
GENERAL MAP
DRAWN R.J.I.
TRACED R.J.I.
CHECKED L.H.G.
SUBMITTED
RECOMMENDED
APPROVED
Bu49-1000
PUEBLO, COLORADO SEPT 1947
7-S

PREFACE

The Arkansas Valley, although one of the most prolific agricultural sections in the State of Colorado, is chronically short of water for most of the lands now being irrigated. In addition, a serious need exists for additional municipal water supplies of improved quality, flood control, sediment control, and electrical power. The residents of the Arkansas Valley have exhausted all possibilities for effecting optiumum utilization of their available water supply without such facilities as would be provided by the Bureau of Reclamation in the Initial Development of the Gunnison-Arkansas Project.

The critical water shortage on the Eastern Slope exists despite the fact that abundant water supplies are found only a few miles away on the other side of the mountainous Continental Divide. The Gunnison-Arkansas Project would divert some of these Western Slope waters through the mountains to the Arkansas Valley where they would be utilized, together with Arkansas River water, to benefit not only the Arkansas Valley but the entire State and Nation. The multiple purposes served by the project include irrigation, municipal water, hydroelectric power, flood control, sediment control, recreation, and fish and wildlife conservation.

The following plans involve diversion of amounts of water that have not been determined to be within the quantity available for transfer from the Colorado River Basin to the Eastern Slope under the allocation to Colorado by the Upper States Compact. Plans "A", "B" and "C" are not adaptable to phase developemtn. Rough calculations indicate that their benefits-cost ratios are less than that of the Maximum Physical Develoment which has a lower ratio than the Maximum Gravity Diversion.

The plan for Initial Developemtn is shown by solid red lines on the General Map and on the Potential Features Map. A total of 58,000 acre-feet of water would be collected and diverted from the upper Fryingpan River on the Western Slope to the Arkansas Valley. In order to protect the interests on the Western Slope, a reservoir would be constructed near the town of Aspen to furnish replacement to prior rights as well as future requirements along the Colorado River. The water imported to the Arkansas Valley would be caught and stored in the Sugar Loaf Reservoir which would be enlarged to nearly 7 times its present capacity. Another reservoir (Twin Lakes), also in the headwaters region of the Arkansas River, would be enlarged almost 5 times its capacity for use in conjunction with the Sugar Loaf Reservoir to store and regulate the diverted waters. Waters of the Arkansas River would be intercepted and conveyed to the latter reservoir by the Snowden Canal; an equivalent amount of water would be released from the potential Pueblo Reservoir immediately with the proper timing as determined by the State Engineer. The terminal Pueblo Reservoir would be located on the Arkansas River 6 miles

west of the city of Pueblo to store and distribute the municipal and irrigation water developed through the project; provide flood protection to downstream areas; and alleviate the damaging effects of sediment deposition. The total capacity of the three reservoirs would be 777,000 acre-feet. In order to obtain maximum utilization of the water, large blocks of hydroelectric power would be produced by the Upper Arkansas Valley Power System, included in the Initial Development. That system, beginning at the Sugar Loaf Reservoir and terminating on the Arkansas River about 10 miles north of the town of Salida, would have a total head of about 2,250 feet. It would consist of about 60 miles of canal, 7 powerplants including one at Pueblo Dam, 8 substations, and 350 miles of transmission lines. Municipal water amounting to 17,000 acre-feet would be supplied to cities and towns requiring additional water by constructing the necessary facilities to deliver the water into the city systems.

The Initial Development is capable of expansion by possible future additional importations. The features required to effect those possible importations would be integrated with those of the Initial Development. The dotted red lines on the General Map indicate the additional features required to effect expansion of the initial plan. These same features are indicated by purple lines on the Potential Features Map. Shown on both maps by solid brown lines are potential Western Slope developments included in the Colorado River Storage Project which could also be integrated with the Gunnison-Arkansas Project.

The most feasible plan for expansion of the Initial Development is the Maximum Gravity Diversion which is briefly discussed in this appendix along with a plan for Maximum Physical Development and various alternative plans.

Chapter I.--The potential project plan

GENERAL DESCRIPTION

The potential Gunnison-Arkansas Project is the major unit in the comprehensive plan of development for the Upper Arkansas River Basin which is being developed by the Bureau of Reclamation. The basic project plan is called the Initial Development. The Initial Development is self-sufficient and not dependent upon any subsequent construction. In addition, the Initial Development provides for the maximum beneficial utilization of water that is assumed divertible under the Upper States Compact and under Colorado State laws. The Initial Development involves the diversion of less than 3 percent of the remaining depletion which could be made by the State of Colorado in accordance with its allocation under compact agreement.

Significant data pertaining to the Initial Development are summarized in the following tabulation:

Transmountain water supply (ac-ft)	58,000
Area to receive supplemental water (acres)	a/322,000
Municipal water (ac-ft)	b/ 17,000
Power:	
Installed capacity (kw)	104,800
Estimated annual generation (one-million kwh)	540

a/ About 2/3 of the supplement requirements.

b/ Additional municipal water could be supplied at the expense of supplemental irrigation water.

The engineering and economic feasibilities of the plan for the Initial Development have been determined in order that construction may begin at an early date to relieve the critical need for supplemental irrigation water, municipal water, hydroelectric power, and flood and sediment control in the Arkansas Valley. The diversion of water from the Fryingpan River, a tributary of the Roaring Fork River in the Colorado River watershed, to the Arkansas River Basin in Colorado is planned in the Initial Development.

On the Eastern Slope a headgate supply of 243,300 acre-feet would be made available to presently irrigated land according to the needs of the various ditches. The remainder of the irrigated land along the Arkansas River would benefit by a better regulated supply through operation of the potential Pueblo Reservoir and the existing John Martin Reservoir. Seventeen-thousand acre-feet of water would be made available to the cities of Pueblo, Colorado Springs, and other towns in the Arkansas Valley for municipal and industrial uses. Saleable hydroelectric energy amounting to 499,500,000 kilowatthours would be available. Construction and operation of the Initial Development would provide flood control, sediment retention and recreational benefits. The life of the project would be in excess of 100 years.

Inasmuch as irrigation is the primary purpose of the development, the entire project should be constructed, operated, and maintained by the Bureau of Reclamation. Appropriate contracts for repayment would be drawn between the Bureau and the beneficiaries.

Many plans, structures, alternate routes, and diversion potentialities have been studied in connection with project development. The smallest feasible plan from an engineering and economic standpoint is the recommended Initial Development. No alternate routes or alernate structures other than possible modification of the potential plan (discussed in detail in Appendix Q, "Alternative Plans") were found in connection with the investigation for the Initial Development.

Additional importations which could result in an expansion of the Initial Development plan, may be possible at some future date. This report, however, is concerned primarily with the Initial Development, and only brief mention is made of any plan for expansion through additional importations.

RECOMMENDED INITIAL DEVELOPMENT PLAN

The recommended Initial Development of the potential Gunnison-Arkansas Project has been designed to fit within the estimated amount of Colorad River water available for transfer to the Eastern Slope under the allocation to Colorado by the Upper States Compact. The Initial Development comprises the smallest practicable plan for the diversion of water from the Colorado River Basin to the Arkansas River Basin considering the many factors involved, such as the critical shortage of irrigation water, the urgent need for more electrical energy on the Eastern Slope, and the economics of costs and benefits.

Major potential features of the Initial Development and the plan for possible future additional importations are shown on exhibit 8 located in the back of this report.

In general, the Initial Development provides for the annual collection of 58,000 acre-feet of water in the Colorado River watershed and its diversion to the Eastern Slope through a transmountain tunnel. Replacement storage on the Western Slope would be provided. The plan would provide facilities for the maximum use of the diverted water together with the Arkansas River water for irrigation, municipal purposes and the production of hydroelectrical energy in accordance with present and future rights, decrees and compacts.

In the Roaring Fork River Basin approximately 77 square miles of drainage area would be intercepted at an elevation of about 10,000 feet on the Fryingpan River and upper tributaries, and above an elevation of 10,700 feet on Hunter Creek, a tributary of the Roaring Fork River. The water would be diverted through a collection system of tunnels, with portals for interception of water courses, to a common point on the Fryingpan River. From there a tunnel, 800 second-feet in capacity and 6 miles long, would divert annually an average of about 58,000 acre-feet of water to the Lake Fork of the Arkansas River.

The North Side Collection System would begin at about elevation 10,125 feet on the North Fork of the Fryingpan River. A series of tunnels would be constructed from that point a distance of 13.6 miles to the west portal of the Fryingpan-Arkansas Tunnel. Water from the South Side Collection System would be intercepted en route. The system, varying in capacity from 165 to 600 second-feet, would intercept runoff from the tributaries on the north side of the Fryingpan River.

The South Side Collection System would begin with an interception of the North Fork of Hunter Creek at elevation 10,700 feet and a tunnel 2.3 miles long from that point to Chapman Gulch. About 2.5 miles below the mouth of the tunnel a second tunnel 4.5 miles long would be constructed in two sections from a point on Chapman Gulch at elevation

10,050 feet to the South Fork of the Fryingpan River where an interception would be made and thence to a point on the southwest side of the Fryingpan River. A 2,100-foot siphon, 84 inches in diameter would be constructed across the Fryingpan River to a junction with the North Side Collection System. The system, varying in capacity from 150 to 300 second-feet, would intercept runoff from tributaries on the south side of the Fryingpan River.

The Fryingpan-Arkansas Tunnel would transport all water intercepted by the North and South Side Collection Systems through the Continental Divide to the Arkansas River Basin. The west portal of that tunnel would be located at elevation 10,000 feet on the Fryingpan River. At that point an interception of that portion of the Fryingpan River immediately above the mouth of the Fryingpan-Arkansas Tunnel would be made. From the east portal at elevation 9,908 feet on Lake Fork, the transmountain water would join the natural waters of Lake Fork and flow down that stream into the enlarged Sugar Loaf Reservoir.

Replacement needs on the Western Slope could be met by the construction of the Aspen Reservoir on the RoaringFork River, about 1 mile above the town of Aspen. A reservoir with an active capacity of 28,000 acre-feet would be created by an earthfill dam. Surface area of the reservoir would be about 650 acres.

A canal of 200 second-foot capacity would be constructed to transport water diverted from Hunter Creek, a tributary of the Roaring Fork River, a distance of 1.7 miles, to the potential Aspen Reservoir, where the water would be stored for replacement purposes.

With a substantial increase in the capacity of the Sugar Loaf and Twin Lakes Reservoirs located on the upper reaches of the Arkansas River, it would be possible to store Western Slope water from years of high flow, thereby creating quantities of firm water in excess of those indicated as divertible during the years of low flow (1930-1941). That firm water could then be used to make up Arkansas River deficiencies in critical water years.

The water diverted from the Fryingpan River would be first regulated and stored on the Eastern Slope in the enlarged Sugar Loaf Reservoir. The existing Sugar Loaf Reservoir, known also as the Turquoise Lake, is owned and operated by the Colorado Fuel and Iron Corporation. That Reservoir would be enlarged by an earthfill dam 140 feet high located on the Lake Fork of the Arkansas River 3.5 miles northwest of Leadville. The capacity of the reservoir would be 117,000 acre-feet with a surface area of 1,550 acres at a normal water surface elevation of 9,880 feet. The surface area at present capacity is 818 acres.

In order to intercept the flow of the Arkansas River for storage and regulation in the potentially enlarged Twin Lakes Reservoir, a diversion dam would be constructed across the Arkansas River 5 miles southwest

of Leadville and the Snowden Canal, at elevation 9,300 feet, with a capacity of 600 second-feet and a length of 10 miles, would be built from the diversion dam to the enlarged Twin Lakes Reservoir.

The existing Twin Lakes Reservoir, located on Lake Creek, 12 miles south of Leadville, would be enlarged from its present capacity of 55,000 acre-feet to a total of 260,000 acre-feet at normal water surface elevation of 9,256 feet. It would be used to store and regulate waters imported by the Fryingpan-Arkansas Diversion and released through the Sugar Loaf Reservoir, together with those imported by the existing Independence Pass (Twin Lakes) Diversion and the water diverted from the Arkansas River by the Snowden Canal. Construction of the project would make possible the diversion of additional water by the Independence Pass Diversion, rights to which are already held by the Twin Lakes Reservoir and Canal Company, but all of the water available under their rights cannot be diverted at present because of the lack of storage space. The Twin Lakes Reservoir enlargement would be made by an earthfill dam 105 feet high about 2,000 feet downstream from the present dam. The enlarged reservoir would inundate 4,160 acres acres and would extend 6 miles up the Lake Creek Valley.

Power development features between the Sugar Loaf Reservoir and the Salida Afterbay on the Arkansas River are referred to as the Arkansas Power System. A canal 60 miles long and ranging in capacity from 300 to 1,000 second-feet, would be constructed between Sugar Loaf Reservoir and Salida Powerplant. Beginning at the enlarged Sugar Loaf Reservoir, the canal would convey project water to the Elbert Powerplant having as its tailrace the enlarged Twin Lakes Reservoir. From that reservoir the water would be carried through 5 more powerplants en route to a point in Browns Canyon 8 miles north of the town of Salida where it would be emptied into the Arkansas River. The canal would intercept Halfmoon, Pine and Chalk Creeks and the Arkansas River at Wapaco. The Chalk Creek Canal would have a capacity of 375 second-feet and would be .5 miles in length. The diversion canal at Wapaco would have a capacity of 600 second-feet and be .4 miles in length.

The Arkansas Power Canal is comprised of the following sections: Elbert Canal, capacity 300 second-feet and length of 19.2 miles; Twin Lakes-Granite Canal, capacity 1,000 second-feet and length of 5.3 miles; Granite-Wapaco Canal, capacity 600 second-feet and length of 7.6 miles; Wapaco-Princeton Canal, capacity 600 second-feet and length of 16.1 miles; Princeton-Johnson Canal, capacity 750 second-feet and length of 8.2 miles; Johnson-Salida Canal, capacity 1,000 second-feet and length of 4.1 miles. Forebays would be located above the Princeton, Johnson Salida Powerplants. The potential power system would include the Elbert Powerplant, on the north shore of the enlarged Twin Lakes Reservoir, the Granite Powerplant, on the north side of the existing Clear Creek (Otero) Reservoir, 500 feet above the dam; the Wapaco Powerplant, near the Arkansas River 7 miles north of Buena Vista; the Princeton Powerplant,

3.5 miles above the mouth of Chalk Creek below Buena Vista; the Johnson Powerplant 8 miles south of the Princeton Plant and the Salida Powerplant on the Arkansas River 8 miles north of Salida. The Arkansas Power Canal would terminate at the Salida Power Drop. Water from the Salida Powerplant would be returned to the Arkansas River and regulated in the Salida Afterbay. From the Salida Afterbay the combined flows of existing and potential transmountain diversions and natural flow of the Arkansas River would continue down the river for impoundment in the potential Pueblo Reservoir to be released for irrigation and municipal uses and, secondarily, for hydroelectric power production.

The Pueblo Reservoir would be formed by an earthfill dam 180 feet high above the stream bed of the Arkansas River, 6 miles west of Pueblo at the site of the existing flood control barrier dam.

The initial capacity of the reservoir would be a total of 400,000 acre-feet. At the end of 100 years it is estimated that the capacity would be reduced by a total of 94,400 acre-feet by the deposition of sediment.

The following tabulation gives the allocation to the various uses of the designed capacity and the estimated capacity at the end of 100 years.

Use	Elevation (feet	Initial capacity (ac-ft)	Capacity at end of 100 years (ac-ft)
Irrigation	4,885	290,000	210,600
Flood control	4,902	100,000	93,000
Dead storage	4,778	10,000	2,000
Sediment storage	..	...	94,400
Total		400,000	400,000

A powerplant would be constructed at the Pueblo Dam for the generation of power from the released water.

Creation of Pueblo Reservoir would require relocation of approximately 20 miles of double track on the main line of the Denver and Rio Grande Western Railroad. The relocation would be accomplished by moving the tracks northward above the high-water line. Maximum grades of 0.6 percent could be maintained, and the degree of curvature for the entire line could be reduced.

As a result of the Initial Development, a headgate supply of 243,300 acre-feet would be made available for irrigation use in the Arkansas River Valley. This total supply includes the 57,500 acre-feet diverted annually from the Fryingpan River, 15,000 acre-feet of additional water

stored annually from the existing Independence Pass (Twin Lakes) Diversion, and an additional 2,000 acre-feet from the Wurtz Ditch diversion, an annual flood flow of 10,000 acre-feet, 110,800 acre-feet annually from winter flows of the Arkansas River, and an additional 25,000 acre-feet evaporation from shallow valley reservoirs which could be saved annually by transfer of storage. Subtracting annual transportation losses of 7,600 acre-feet, evaporation losses of 16,000 acre-feet and the 17,000 acre-feet to be made available to the cities of Pueblo and Colorado Springs and the towns in the Arkansas Valley for municipal and industrial uses, the net water would be 179,900 acre-feet. However, there would be return flow of 10,500 acre-feet annually from the municipal water, which would bring the net water to 190,400 acre-feet annually.

Except for the Arkansas River winter water all of the net water is reused 1.64 times, giving a headgate supply of 243,300 acre-feet annually. The following tabulation shows the amounts of water which could be made available for irrigation use by the Initial Development.

Water available for irrigation use in Arkansas River valley as result of Initial Development - averages for period 1911-1944.
(Unit: acre-feet)

Item	Gross water	Losses		Net water	Headgate supply a/
		Transportation	Evaporation		
Fryingpan River Diversion	b/57,700	6,200			
Arkansas River flood flows stored	c/10,000	--	d/12,000	49,500	
Additional Wurtz Ditch imports	2,000	--	--	2,000	
Municipal water	--	--	--	-17,000	
Subtotal				34,500	56,600
Return flow municipal water	--	--	--	f/10,500	17,200
Additional Twin Lakes imports	e/15,000	1,400	1,000	12,600	20,700
Winter flow of Arkansas River stored in Pueblo Reservoir	g/110,800	--	3,000	107,800	107,800
Evaporation savings from valley reservoirs	25,000	--	--	25,000	41,000
Total water made available for irrigation	220,500			190,400	243,300

a/ Virgin water reused 1.64 times except for Arkansas River winter water.
b/ Gross diversion less 5,000 acre-feet Busk-Ivanhoe water.
c/ Flood flows in excess of storable flow in John Martin Reservoir principally in years such as 1921, 1923, and 1942.
d/ 4,000 evaporation Twin Lakes and Sugar Loaf plus 8,000 evaporation Pueblo.
e/ Additional diversions made possible by project storage.
f/ 70 percent of 15,000 acre-feet
g/ Winter flow Arkansas River physically storable in Pueblo Reservoir.

The winter flows and evaporation savings of the Arkansas River could be conserved for more beneficial irrigation use only by mutual agreements among the appropriators and in conformance with all rights, decrees and compacts. All irrigation water conserved by the Initial Development would be for supplemental purposes only. No new lands would be irrigated.

A total of 4,000 acre-feet of supplemental water would be allocated annually to Colorado Springs in the Initial Development. Of this total, an average of about 2,700 acre-feet could be supplied annually to Colorado Springs by exchange procedures. The remaining 1,300 second-feet would be used for replacement and additional supply from sources now under investigation. The water could be obtained by a diversion from the Beaver Creek watershed through the city's existing system, thereby increasing the present municipal supply of 8,200 acre-feet per year to a total of 10,900 acre-feet. That part of the 2,700 acre-feet of water used by the Penrose-Beaver Park area north of Florence could be replaced, if necessary, by water from the Mount Pisgah Reservoir which would be made available to the Penrose-Beaver Park area by the construction of a ditch from Oil Creek to the existing Brush Hollow Reservoir. Because of transportation and other losses it would be necessary to obtain approximately 3,200 acre-feet from Oil Creek to deliver the replacement 2,700 acre-feet to the irrigators. The Oil Creek depletion in turn would require replacement to satisfy irrigation rights for Oil Creek water now diverted from the Arkansas River. That replacement would be effected by use of water imported by the Initial Development. By generating power from the additional water diverted from Beaver Creek above the Skaguay Reservoir, the city of Colorado Springs could compensate the Southern Colorado Power Company for the loss of power now generated by the Skaguay Powerplant, thereby making available for irrigation storage that portion of the Skaguay Reservoir now used for power water regulation.

A supplemental supply of about 5,000 acre-feet of water could be made available for municipal use by the city of Pueblo. Two thousand acre-feet of this water would come from the storage of water imported by the municipally-owned Wurtz Ditch. Most of the water diverted by that ditch from the Colorado River Basin near Leadville is lost because of insufficient storage space. The water now lost by lack of storage could be made available by the Gunnison-Arkansas Project system. The present supply of 21,000 acre-feet per year could be handled in the project system and combined with the 5,000 acre-feet of additional water to give Pueblo a total annual supply of 26,000 acre-feet.

An additional 8,000 acre-feet of water would be supplied to other municipalities in the Arkansas Valley by a trunk line from Pueblo Reservoir with branch lines to outlying communities.

Large reservoir storage should be provided for carry-over to years of low flow. In addition to that required for carry-over purposes, large storage is necessary in order that the quality of water for municipal uses at Pueblo and towns below can be maintained.

An estimated total of 540,000,000 kilowatthours of hydroelectric power would be generated, of which 499,500,000 kilowatthours are saleable and the balance is transmission losses of 7-1/2 percent and station use. This saleable power would furnish revenue for project repayment as well as provide a sound basis for industrial expansion.

Estimates of cost

The cost of the Initial Development, based on January 1949 prices, is estimated to be $141,241,000. The allocation of costs to the various uses is included in Appendix P, "Financial Analysis" along with the detailed discussion of Benefits and Repayments.

Benefits

The Arkansas River Valley in central and southeastern Colorado is potentially a most productive agricultural and industrial center. Lack of adequate supplies of water and power, two of the greatest sources of wealth and prosperity known to man, has largely prevented the full development of the resources of this vast area. With an augmented and dependable water supply the valley would have unlimited potentialities. The presently irrigated land would not suffer the damaging effects of seasonal and even prolonged droughts. An adequate water supply of improved quality would be made available for municipal and industrial uses. Jobs and homes for thousands of additional families from overcrowded areas would be created. Critical materials now lying as undeveloped resources could be developed to alleviate existing shortages, and industrial plants would be created to supply a greatly improved economy and for use in the event of a national emergency. Large blocks of power from a renewable source would be supplied for full industrial development which would convert the raw materials produced in the region to finished commodities, thereby benefiting not only the region but the Nation as a whole. In fact, total annual benefits from the Initial Development would amount to $10,296,000 compared to the annual cost of $5,149,000; that is, for each dollar expended to construct, operate, and maintain the project 2 dollars would be returned to the Nation in benefits.

The Initial Development would make available unallocated waters from the Fryingpan River diversion area which, with water from the Arkansas River, would alleviate the urgent need for supplemental water by the Arkansas Valley water users.

Improvement of irrigation facilities and the generation of large blocks of hydroelectric power for the development of natural resources and industrial expansion represent only a portion of the beneficoal results that would accrue from project construction and operation. Municipal and industrial water supplies in the valley would be augmented, and quality greatly improved, recreation and fish and wildlife areas would be provided, flood and sediment control in the valley would be improved, and stream pollution would be abated. Although the extent of gains would, in some degree, be directly proportional to the amount of water diverted from the Western Slope, the project would provide greater wealth, support additional thousands of persons and provide extensive benefits to the project area, to the State and to the Nation.

Repayment

Under the plan herewith proposed, the total construction cost of $141,241,000 for the Initial Development would be repaid in full. Capital costs allocated to irrigation and municipal water would be repaid over a period of 60 years, the former being interest-free, and municipal water bearing an interest rate of 1.67 percent. The cost of additional facilities required to carry the municipal water from project structures to the towns would be repaid in 40 years at 2-1/2 percent interest. The Bureau of Reclamation would sell the imported water at a reasonable price to a conservancy district which in turn would sell the water to the water users. An ad valorem tax of 1 mill would be levied against the conservancy district to repay a part of the costs allocated to irrigation. Power costs would be repaid in 50 years at 3 percent interest and the entire cost of the project would be repaid in 60 years with a substantial surplus. National benefits would accrue to flood control, sediment control and recreation, and nonreimbursable costs have been allocated to these items accordingly.

Chapter II.--Alternate plans

GENERAL DISCUSSION

In addition to studies made for the basic project plan, or the Initial Development, other studies were made to find the most practical plan for maximum development from an engineering standpoint. Many features were found worthy of investigation, but proved unsuitable for incorporation into the project. Some of these features are included in the alternative plans discussed briefly in this chapter. The Maximum Gravity Diversion, which is the most feasible plan for expansion of the Initial Development is treated in more detail. The Maximum Physical Development, a possible enlargement and extension of the Maximum Gravity Diversion, and Alternate Plans A, B, and C, are given but brief treatment. All of the plans are discussed in detail in Appendix Q "Alternative Plans".

MAXIMUM GRAVITY DIVERSION

This possible expansion of the Initial Development would enable the annual diversion of an additional 597,000 acre-feet of water from the Colorado River Basin to the Arkansas River Basin. About 400,000 acre-feet could be obtained from existing flows of the Slate, East and Taylor Rivers in the Gunnison River Basin. The remaining 197,000 acre-feet would consist of a rediversion of water originally diverted from Anthracite Creek which is a tributary of the North Fork Gunnison River; from the upper Crystal River; and from Maroon, Castle, and Difficult Creeks which are tributaries of the Roaring Fork River.

A diversion of about 60,000 acre-feet could be made from the Anthracite Creek watershed at elevation 9,300 feet. The water would be collected by conduits and tunnels and conveyed to the portal of the main diversion tunnel in the Dark Canon. That tunnel would carry the intercepted waters through the Cascade Mountain to Poverty Gulch, a tributary of the Slate River.

An average of about 90,000 acre-feet of water per year could be diverted at elevation 9,500 feet from the upper Crystal River, a tributary of the Roaring Fork River. The water would be conveyed by tunnels and conduits to the west portal of the Crystal River diversion tunnel. That tunnel would convey the water through the Elk Mountains to the Slate River.

Diverted waters from Anthracite Creek and from the Crystal River would join the natural waters of the Slate River and flow down that stream to a point about 1/2 mile above the confluence of the Slate and East Rivers. The combined intercepted waters of Anthracite Creek and the Crystal, Slate, and East Rivers would then be diverted and conveyed along the east side of the East River valley by tunnel and canal to the potential Almont Reservoir. Water from Cement Creek would be intercepted en route.

The potential Almont Reservoir would be created by a concrete arch dam to be located approximately 4 miles northeast of the town of Almont. The primary purpose of the Almont Reservoir would be to regulate water for diversion to the Eastern Slope although power would be generated at the dam by uniform water releases incident to fish culture.

From the Almont Reservoir, the potential Gunnison-Arkansas Tunnel at elevation 8,471 feet, would divert water north and east through the Continental Divide to the Arkansas River Basin. Auxiliary pumping into the transbasin tunnel would be necessary at times of low water levels in the Almont Reservoir.

Diversion of an average of approximately 47,000 acre-feet annually could be made at elevation 10,150 feet from the upper Maroon, Castle, and Difficult Creeks drainages which are tributary to the Roaring Fork River. Water would be intercepted at various stream crossings and conveyed to the main diversion tunnel by tunnels and conduits. The main diversion tunnel would transport the water through the mountains to the Taylor River where it would join the natural waters of the river and flow to the Taylor Park Reservoir, an existing feature of the Uncompahgre Irrigation Project that was completed in 1937 by the Bureau of Reclamation. Projected use in the potential plan would necessitate enlargement of the reservoir.

The Taylor Park Reservoir could be enlarged by increasing the height of the present earth dam. The primary use of the enlarged reservoir would be to store and regulate waters for diversion to the Eastern Slope. Power could be developed, however, from water released into a vertical shaft leading to the transbasin Gunnison-Arkansas Tunnel and through a powerplant located about 800 feet underground below the Taylor Park Reservoir.

Water not diverted through the shaft would flow down the Taylor River to the potential Almont Reservoir. The capacity of the Taylor Park Reservoir now allotted to the Uncompahgre Irrigation Project near Montrose would be replaced by equivalent storage in the potential Curecanti Reservoir on the Gunnison River.

Divertible waters from the potential Almont Reservoir and from the enlarged Taylor Park Reservoir would flow eastward through the Gunnison-Arkansas Tunnel which would emerge on Cottonwood Creek, about 3 miles above its confluence with the Arkansas River at Buena Vista.

The diverted water from the Gunnison-Arkansas Tunnel would enter the Arkansas Power Canal near Cottonwood Creek. There it would join the Western Slope and Eastern Slope waters from the north. All waters, including accretions obtained en route, would be transported southward in the power canal at the Salida Powerplant and would be used for the generation of electricity in the Princeton, Johnson and Salida Powerplants.

Water from the Salida Afterbay would flow by way of a system consisting of a canal and a tunnel to the potential Wellsville Powerplant on the north side of the Arkansas River about 4 miles east of Salida and 1 mile west of the town of Wellsville. After passing through the Wellsville Powerplant the combined waters would be returned to the Arkansas River.

The existing State Ditch near Canon City, which was never completed, would be rebuilt and extended to divert water from the Arkansas River for the municipal needs of that city and to supply additional water to the Penrose-Beaver Park area. This plan would enable Colorado Springs to divert more water from the upper reaches of Beaver Creek for municipal purposes.

All other water would continue down the Arkansas River to the Pueblo Reservoir, constructed under the Initial Development, which would be enlarged to 800,000 acre-feet capacity. The water would be stored here and released as needed for irrigation and municipal uses.

Additional downstream reservoir capacity could be provided by enlarging the existing Horse Creek Reservoir.

The increased water supply would enable the irrigation of about 220,000 acres of new lands which could be supplied water by extensions of existing canals and by the construction of some new canals. Laterals, and adequate drains would be necessary. Areas to be irrigated have not been definitely selected. Additional land classification studies and more detailed surveys will be required before satisfactory routes can be determined and adequate designs can be made.

In addition to the 2,700 acre-feet of water furnished to Colorado Springs under the Initial Development, 10,300 acre-feet would be supplied under the Maximum Gravity Diversion. This 10,300 acre-feet would also be obtained from the Beaver Creek watershed. The diverted water would be collected into an enlarged Skaguay Reservoir and diverted from West Beaver Creek below Skaguay into a pipeline for conveyance to the city's existing municipal supply system. Replacement to the Penrose area would be made from the State Ditch by means of a pumping plant and pipeline to Brush Hollow Reservoir and construction of irrigation ditches.

An annual amount of approximately 1,000 acre-feet of water could be made available to the town of Salida. This water would be carried by pipeline from the Salida-Wellsville Canal to the town's distribution system. The necessary storage at the head of the pipeline would be provided.

Approximately 2,000 acre-feet of additional water could be supplied to Canon City. This amount, along with their present supply, would be furnished through the State Ditch.

The city of Pueblo could recieve an additional 16,000 acre-feet of municipal water to supplement their present supply of 21,000 acre-feet. This entire amount would be pumped from Pueblo Reservoir to a purification plant where it would be purified along with the amount supplied to the Arkansas Valley towns below Pueblo. From the purification plant, located near the Pueblo Reservoir, the water would be piped to the city's present municipal supply system.

The towns in the Arkansas Valley below Pueblo could be furnished 13,000 acre-feet of municipal water. This supplemental supply would be stored in the Pueblo Reservoir and purified along with the municipal water supply for Pueblo. A separate pipeline would convey the water from the purification plant to the valley towns.

The Maximum Gravity expansion features, when added to those of the Initial Development, would provide a total project transbasin diversion of about 655,000 acre-feet of Western Slope water to the Arkansas River Basin. In addition to alleviating the need for supplemental irrigation water, about 45,000 acre-feet of municipal water could be made available for municipal purposes and a total of about 220,000 acres of new land could be irrigated. Total hydroelectric power which could be generated would approximate 1,500 million kilowatt hours per year, thereby enhancing project repayment ability and providing a basis for further industrial expansion within the project area.

Gravity Diversion extension

If the need for additional electricity should become critical, additional power could be generated by the construction of a series of tunnels to the mouth of the Texas Creek on the Arkansas River, then to Webster Park on Grape Creek and finally to the mouth of Grape Creek near Canon City with powerplants at the places named. Interceptions could be made from the Arkansas River near Wellsville and Texas Creek. This extension would reduce the cost of power and could be built in accordance with an increased power market demand. About 1,000 million kilowatthours could be generated annually making a total project output of 2,500 million kilowatthours yearly.

MAXIMUM PHYSICAL DEVELOPMENT

This plan, which would be an enlargement and extension of the Maximum Gravity Diversion, is based on the maximum possible physical diversion of Western Slope waters to the Arkansas Basin in Colorado. The diversion would average 990,000 acre-feet per year which amount has not been determined to be available for transfer from the Colorado River Basin to the Arkansas River Basin under the allocation to Colorado by the Upper States Compact.

The Maximum Physical Development would generally include the Maximum Gravity Diversion and additions to the collection, distribution, and power system thereof. In addition to the features described for the Maximum Gravity Diversion, this plan would contain a collection system in the lower Gunnison Basin, consisting of Gateview, Cebolla and Blue Mesa Reservoirs, from which water would be pumped to the Almont Reservoir and the Gunnison-Arkansas Tunnel where it would flow together with waters from the Almont and Taylor Park Reservoirs to the Eastern Slope. The system would be further enlarged and extended by means of tunnels and canals to the Graneros, Cedarwood and Ben Butler Reservoirs south of Pueblo. Distribution from the Ben Butler Reservoir would be made east and west of the Huerfano River to new lands and to lands needing a supplemental water supply. The Arkansas Valley Power System would be completed to full capacity in this stage of development, and about 3.5 billion kilowatthours of hydroelectric power would be produced over and above that consumed by pumping.

As in the Maximum Gravity Diversion 45,000 acre-feet of municipal water would be furnished to Pueblo, Colorado Springs and the Arkansas Valley towns. The water for Pueblo and the Arkansas Valley towns below Pueblo would be piped from Graneros Reservoir to the purification plant near Pueblo. From here, it would be piped to Pueblo and the lower Arkansas Valley towns.

ALTERNATE PLAN A

This plan for diversion of 990,000 acre-feet of water from the Colorado River Basin to the Arkansas River Basin embraces all of the preferred Maximum Physical Development except that section on the Western Slope from the Almont Reservoir to Cottonwood Creek in the Arkansas Valley west of Buena Vista and that section on the Eastern Slope from Cottonwood Creek to the Cedarwood Reservoir. The grade on the Cabin Creek-Almont Tunnel would be changed so that water would flow from the Almont Reservoir to Cabin Creek instead of the opposite direction as it does in the Maximum Physical Development. From Cabin Creek, water would be conveyed through the Continental Divide to a point under Mt. Ouray about 7 miles southwest of Salida where it would be joined by water from the Fryingpan Diversion and the upper Arkansas River brought to that point from Cottonwood Creek. From Mt. Ouray the route would pass through the San Luis Valley to the Huerfano River Valley and the Cedarwood Reservoir. Approximately 3.2 billion kilowatt-hours of hydroelectric power would be produced over and above that consumed in pumping.

As in the Maximum Gravity Diversion, 45,000 acre-feet of additional municipal water would be furnished. Distribution of the municipal water would be the same as in the Maximum Gravity Diversion.

ALTERNATE PLAN B

Alternate Plan B includes all of the Maximum Physical Development except that section on the Western Slope from the Almont Reservoir to Cottonwood Creek in the Upper Arkansas River Basin west of Buena Vista and that section on the Eastern Slope from Cottonwood Creek to the Boulah Canal about 8 miles south of Florence. The grade of the tunnel from Cabin Creek to Almont would be reversed as in Alternate Plan A. The remainder of the plan would consist of tunnels and canals from Cabin Creek through the Continental Divide to Maysville and thence

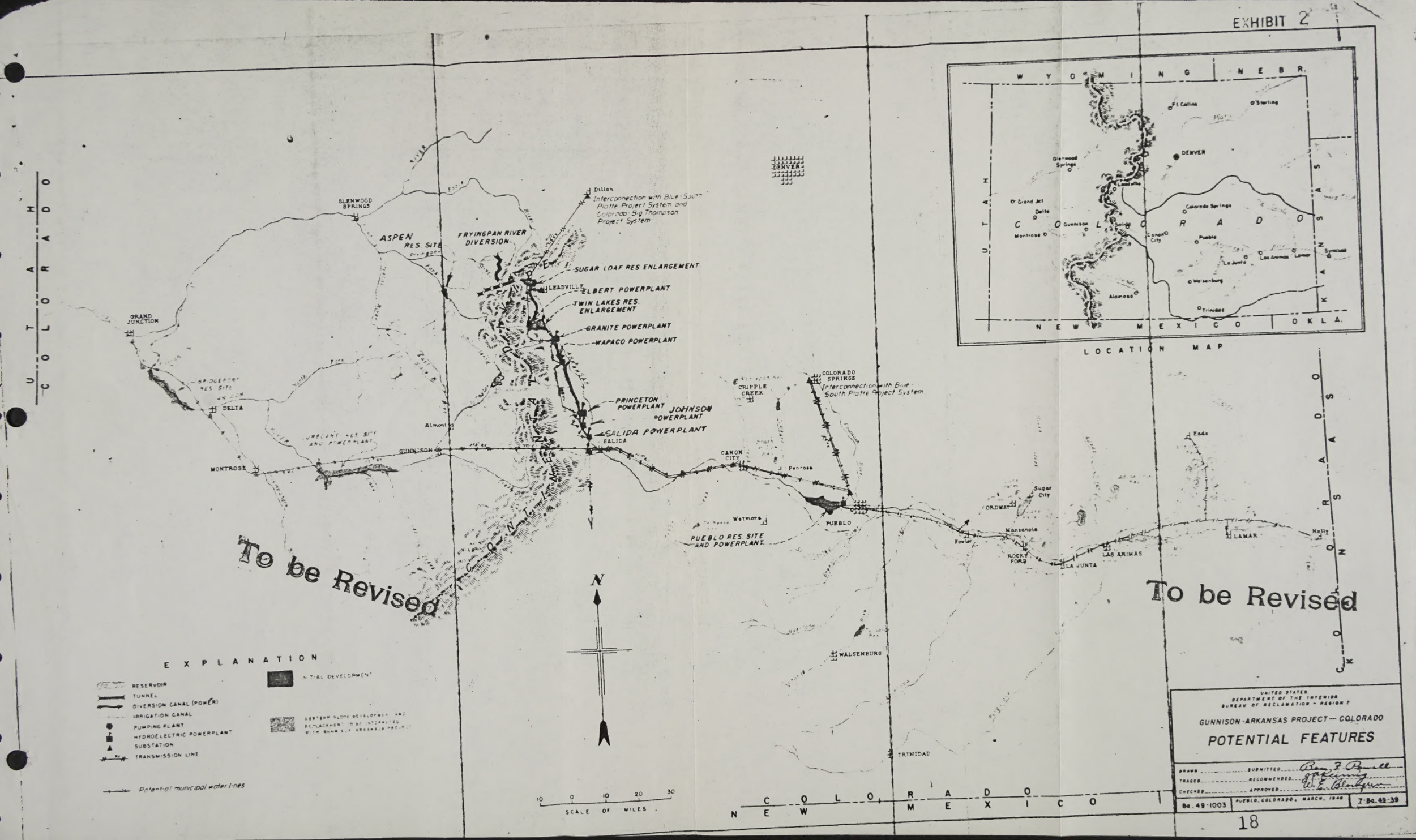
through the Wet Mountain and Huerfano River Valleys to the Beulah Canal south of Florence. As in Plan A, about 990,000 acre-feet of water would be diverted. About 3.1 billion kilowatthours of hydroelectric power would be generated.

As in the Maximum Gravity Diversion 45,000 acre-feet of additional municipal water would be furnished. Distribution of the municipal water would be the same as in the Maximum Physical Development.

ALTERNATE PLAN C

This plan is a potential plan for transporting water from the upper Roaring Fork and Gunnison Basins and water pumped from the potential Blue Mesa Reservoir, via the San Luis Valley and the upper Huerfano River Basin to the Graneros Reservoir from which it would be conveyed and distributed through a system the same as that of the lower portion of the Maximum Physical Development. The Fryingpan River Diversion, and the secondary diversions consisting of Anthracite Creek, Crystal River and Maroon and Castle Creek, would also be incorporated in this plan. About 990,000 acre-feet of water would be diverted from the Gunnison and upper Roaring Fork Basins to the Arkansas Basin. About 3 billion kilowatthours of hydroelectric energy would be generated, of which approximately 1.2 billion kilowatthours would be consumed in pumping 45,000 acre-feet of additional municipal water would be furnished to the cities and towns as in the Maximum Gravity Diversion. Distribution of water in this plan will be the same as in the Maximum Physical Development.

EXHIBIT 2



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION - REGION 7

GUNNISON-ARKANSAS PROJECT — COLORADO

POTENTIAL FEATURES

DRAWN	SUBMITTED	Ben F. Powell
TRACED	RECOMMENDED	Regional
CHECKED	APPROVED	W. E. Bleuler

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